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PLANTING AND ESTABLISHMENT OF TREES, SHRUBS, GROUND COVERS AND VINES

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE

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PLANTING AND ESTABLISHMENT OF TREES, SHRUBS, GROUND COVERS AND VINES

1. PURPOSE. This manual provides guidelines and prescribes standard practices and techniques to be used in planting and initial care for the successful establishment of trees, shrubs, ground covers and vines. The manual sets forth criteria for selection of materials and describes each step to achieve the desired objectives of a planting plan. The guidelines apply to military installations of the Army, Navy and Air Force, and to Civil Works projects of the Corps of Engineers.

2. SCOPE. This manual describes the various ways plants are grown for transplanting, how they should be prepared for moving, how they should be planted, and procedures to follow while the plants become adapted to their new location. The manual cannot impart the full knowledge of a landscape contractor, nurseryman or landscape architect in selecting plants, soils and additives for special purposes. However, the manual provides basic information necessary for successful planting and initial care of most plant materials. The planting of trees, shrubs, ground covers and vines should be in accordance with approved landscape planting plans and based on the master plan for future development of the installation. Planting design principles to apply and objectives to achieve in developing planting plans are described in TM s-830-1, Planting Design.

3. REFERENCES.

TM 5-630/AFM 85-6 Facilities Engineering, Grounds Maintenance and Land Management

TM 5-820-4/AFM 88-5, Chap. 4 Drainage and Erosion Control, Drainage for Areas Other Than Airfields

TM 5-830-l/NAVFAC P-904 Planting Design

TM 5-830-2/AFM 88-17, Chap. 4 Planting Turf

TM 5-830-3/AFM 88-17, Chap. 3 Dust Control

"American Standard for Nursery Stock" 260.1, American National Standards Institute (ANSI)

4. PLANTING SEASONS. In most parts of the country, the most favorable time for planting is during the inactive or dormant periods of the plant. There are certain geographic locations, generally in warm regions, where plants may be moved at almost any time. Even in such areas, however, plants have growing cycles. Planting during the active growing period of the plant should be avoided since great care is necessary to move plants successfully at such an unfavorable time. Often when plants are set out during the wrong season, they will survive only after heavy cutting back, remain in a very weakened condition, and show little

or no leaf growth until the following growing season. Expense is increased by the necessity of utilizing more careful and laborious transplanting methods and by the lengthening of the period of artificial watering. Recommended planting periods for a particular geographic location can be obtained from a County Agent, Soil and Water Conservation District, Federal, State, County and City Park and Forest Agencies. When moving plants at times other than recommended, an anti-desiccant should be used. Anti-desiccants are materials which protect trees, shrubs and other plants from excessive moisture loss, thereby reducing plant shock. Anti-desiccants also prevent winter-kill, summer scald, and disease. Spraying liquid anti-desiccant on the foliage prior to digging the plant from its original location allows planting or transplanting operations during active growing periods. The most favorable periods for planting are as follows:

4.1 Temperate Zone. Deciduous plants may be moved in the fall after the first frost but before the ground freezes, or in the spring after the ground thaws but before the leaves appear. Evergreens in more northerly areas are best planted in the late summer after new growth has hardened, or in the spring somewhat later than deciduous plants. Farther south in the temperate zone where the ground seldom freezes, deciduous plants may be moved whenever they are leafless and evergreens may be moved during the same period.

4.2 Subtropic Zone. In the sub-tropic areas, no definite planting periods exist and it is possible to move most plants with fair success whenever they are not in a period of vigorous growth. Palms and bamboos are most easily handled in early summer. Oaks, including live oaks, are difficult to transplant except during the winter when they are relatively dormant. Even in the sub-tropics, much is to be gained by planting during cooler months unless plants are container-grown or otherwise handled with special care. For instance, collected wax myrtles planted during hot weather require heavy pruning and usually put out little foliage before the following spring. Planted in winter or spring, wax myrtles will be effective at once and will not require much pruning.

5. QUALITY OF PLANTS. The most important step in assuring successful planting is to select plants of the highest possible quality. Widely accepted criteria are established by the "American Standard for Nursery Stock", ANSI Z60.1. Quality measured by these criteria is achieved through good nursery practices. These reliable practices produce plants which have desirable branching characteristics and are conditioned for successful transplanting. The standards are accepted throughout the landscape industry and by governmental agencies. Several additional common sense "rules of thumb" can be applied in selecting plants. Plants should be grown or collected from an area having a climate similar to that of the planting site. This improves the chances of plants becoming established in the new location. Collected plants are usually inferior to nursery-grown plants in both appearance and ability to survive transplanting. This is because normal nursery practices such as pruning of tops and roots, fertilizing and cultivation have not been applied. Collected

plants usually have widely branched root systems due to lack of root pruning. Consequently, a large proportion of the root system is lost in transplanting. Collected plants should be avoided unless qualified personnel conduct and direct the operation and a lower grade of plant is acceptable. Nursery-grown or collected plants delivered to the project site should not be used if the plants have bruised bark, broken primary limbs, unbalanced growth, off-color foliage, insect infestation, or diseased wood. Plants infested with insects or having diseased wood are not only undesirable, but are potentially contagious to existing vegetation in the vicinity. Any of the above characteristics indicate inferior plants and give rise to future problems during the establishment period.

6. HANDLING AND TRANSPORTATION. During handling and transportation, it is very important that roots remain moist and tops are not subjected to sun and wind conditions which cause excessive evaporation. Scarcely any plant will survive if its roots have once been dried out; most plants are set back seriously by the drying of even the fine roots. Exposure of the tops to wind and sun puts a demand for moisture upon plants, a demand that cannot be supplied while the plant is out of the ground and serious injury often results. Moisture can be kept in the plants by spraying the branches and foliage with an anti-desiccant (anti-drying agent) prior to digging and by covering the tops. Bare root plants must be protected from loss of moisture by loose wrapping of the roots in such material as wet burlap immediately after they are dug. Care in handling and transportation shortens the time required for plants to become established in a new location.

6.1 Handling. Other factors being equal, plants taken from containers in which they have been growing start new growth most rapidly. Plants moved with solid, natural balls of earth enclosing most of the roots show only slightly less speed of recovery. Plants moved with roots bare of earth recover more slowly than those handled by the other two methods. The probability of success in transplanting is increased if the roots of the plant are pruned in advance of the growing season just prior to transplanting to induce compact root growth. Root pruning is a standard nursery practice. It consists of cutting the roots with a sharp spade or, in the case of deeply rooted plants, by trenching and backfilling around the perimeter for transplanting with a larger ball in a future planting season. When moving collected plants from the project area or from the wild, such advance root pruning or trenching/backfilling may make the difference between success and failure. The various methods of handling are described below:

6.1.1 Container-grown plants. Healthy, young plants grown in containers offer ease of handling and better storage life, and they start new growth most rapidly. Containers in which plants are commercially grown include wooden flats, earthenware pots, metal cans, plastic pots, wooden boxes, metal tubs and wire mesh baskets. Small container-grown plants have become increasingly available and less expensive than balled and burlapped plants in most parts of the country. Plants properly grown in containers will have a root system sufficiently developed to hold the soil

solidly together during handling and removal, but not so far developed that the roots are bound tightly together to the detriment of future satisfactory growth. If plants are held in containers too long, they become root-bound and stunted. Such plants usually grow very poorly and do not achieve their intended form. When purchasing container-grown plants, it is advisable to spot-check root conditions prior to planting for possible rejection.

6.1.2 Balled and Burlapped Plants (B&B). The greatest benefit of balling and burlapping a plant is that mature-sized material can be moved to produce an immediate landscape effect. The balling and burlapping operation, to be successful, demands experience and must be performed under the supervision of trained personnel. The cost of moving plants with natural earth balls is considerable, but this method is the only way to move certain species of plants successfully. Plants handled in this manner require less severe pruning, become established more rapidly, and need less attention during the establishment period than bare root plants. Under normal circumstances, the unbroken ball of earth is securely wrapped with cloth or burlap and stitched with box nails or, in the case of heavier plants, bound with cord, twine, or light rope. Where plants are growing in heavy clay soils, it may be possible to move the plants with earth balls intact without the necessity of wrapping. Where plants are growing in light and sandy soils, it is usually impossible to obtain a satisfactory ball since the soil lacks sufficient cohesion. These plants may be better handled bare root, since most plants growing under these conditions do not develop dense, compact root systems. Plants with crushed, broken or cracked earth balls are not likely to survive and should be rejected. To facilitate handling, very heavy earth balls are often mounted on and securely tied to strong wooden or metal platforms which act as skids and provide a means of lifting the plant onto a truck for transportation. This method is referred to as "balled and platformed". Other techniques have been developed in recent years which involve the use of tree spades designed to dig and transport plants without disturbing the roots. There is no need to wrap the ball of earth since it is contained by the same metal plates employed in the digging. Use of these machines is generally restricted to short-haul operations but has produced very satisfactory results, particularly when plants must be moved out of season.

6.1.3 Bare Root Plants (B.R.). Another method of handling is by removing the plants from the ground with the roots bare of soil. This is a common practice, especially when transplanting small plants. This method should not be used except during the dormant period. It can rarely be used for successful transplanting of other than seedling evergreen plants. Large deciduous plants dug with bare roots require heavy pruning of tops to compensate for the loss of roots and rootlets. Sound judgment must be used in determining the minimum spread at which the roots may be cut without serious injury to the plant. The shock of bare root transplanting is more severe than with other methods and recover), is more prolonged. Earth most be removed from the roots very gently so that they are damaged as little as possible. Where circumstances permit, the

puddling of the roots in very wet clay immediately upon digging will prevent them from drying out.

6.1.4 Collected Plants. Deciduous collected plants can be moved either balled and burlapped or bare root, but other than seedling evergreen plants should always be moved balled and burlapped. Regardless of the method used, collected plants should be root-pruned in place at least one growing season prior to transplanting and plainly tagged for ease of identification.

6.1.5 Existing Vegetation. The possibility of transplanting existing vegetation which must be removed from a construction area should be given careful consideration for incorporation in the planting plans. Whenever possible, existing plants to be moved should be root-pruned in advance of the growing season. The plants should be handled as described for Collected Plants. If they cannot be replanted immediately after removal from the ground, excessive loss of moisture must be prevented by the same methods as described for storing plants on the site.

6.2 Transportation. On or before delivery, plants should be inspected for correct size, type and quantity. They should be examined for damage, insects, and wilting. The plants should show they have been properly cared for, have no unsightly irregularities, and are in satisfactory condition. Careful handling takes time but pays with better end results. Plants should be loaded on trucks carefully and tied down securely to prevent movement and subsequent damage to bark and limbs during transportation. Like-materials should be grouped together. Plant tops should be covered to protect them from sun and wind damage. They can be severely damaged, e.g. in an uncovered truck traveling at 50 mi/h by the whipping action of the wind and accelerated moisture loss. Plants, including evergreens, will suffer less damage if the branches of each plant are bound with twine or light rope. Larger plants should be loaded with roots toward the front of the truck so that the wind will be swept up through the branches. In all loading operations balled plants should be handled gently, especially when tipping them on their sides in the truck. One side of the ball should be lifted rather than tugging on the trunk or branches. Excessive rolling or dragging a tree ball should be avoided because such actions tend to loosen the soil, destroy the cohesiveness of the ball and break many small roots. Delivery should be coordinated with planting operations to avoid prolonged storage on the site. Bare root plants should be given top planting priority because they are most vulnerable to moisture loss. The shorter time a plant is out of the ground, the better. If it is not possible to plant on the same day as delivery, storage in a protected area and additional watering are necessary. Board ramps or mechanical aids should be used to load and unload large plants from the truck. Plants dropped over the side or off the tailgate should be rejected, as damage to the root system is highly probable even though it may not be apparent.

7. SOIL AND ADDITIVES. Guidelines herein concerning soil and additives are related only to planting of trees, shrubs, vines and ground cover

plants. TM s-830-2, "Planting Turf", describes the soil and additives related to planting of turf. More often than not, soil available at the site of planting will not be wholly satisfactory for vigorous growth and must be improved by the addition of other materials.

7.1 Soil. Whenever available, soil for backfilling plant pits or beds should be natural, friable (easily pulverized), fertile topsoil that has demonstrated capability of sustaining vigorous plant growth. The topsoil should be of a uniform composition containing no subsoil, twigs, clumps of grasses, stones or hard shale larger than one inch, toxic substances or other extraneous material. Soil having these general qualifications is usually adequate to promote and stimulate plant growth. Topsoil can be that which was previously stripped from the site and stockpiled prior to grading operations or can be from another site located in the general area of the planting project. (If topsoil is taken from another site, enough topsoil should be left covering the "borrow areas" to support a rough seeding of grass.) Stripping of topsoil should be done carefully to prevent stirring up the subsoil and mixing it with the topsoil. If natural topsoil cannot be obtained locally in sufficient quantity, available soil should be tested for soil acidity (pH) and organic content by a qualified testing laboratory. Local agencies such as a State Agricultural Experiment Station, County Agent, Soil and Water Conservation District, State University or other private organization may be contacted for information about procedures and methods of obtaining laboratory tests along with their precise directions for sampling. Should laboratory tests indicate that the soil to be used is deficient, it will be necessary to provide soil additives. The laboratory test report should include specific recommendations on quantities required to bring the soil to acceptable levels of acidity (pH) and organic content.

7.2 Additives. Various materials may be needed to improve substandard soil, but precautions must be taken in their use.

7.2.1 Soil Conditioners. The addition of soil conditioners improves the friability and, except for sand, the moisture-retaining capacity of the soil. Humus (peat), spent manure, sand, and commercially available minerals such as vermiculite and perlite can be mixed with the planting soil. As a general rule, if laboratory soil tests for friability cannot readily be obtained, a mixture of one part sand or mineral soil conditioner, one part humus and one part soil will provide a soil mixture suitable for planting trees and shrubs.

7.2.1.1 Sand and Minerals. Sand or such minerals as vermiculite and perlite are especially useful for making heavy clay soils more friable. Since none of these soil conditioners contain plant nutrients, they should be supplemented with fertilizer. Sand is usually the most readily available and inexpensive material, but is much heavier than mineral conditioners. Vermiculite and perlite are light in weight and, therefore, ideal for planter boxes or roof gardens where the load factor is a significant consideration.

7.2.1.2 Humus. Humus, which may be in the form of moss, reed or sedge peat, can be added to the soil to provide organic matter and stimulate plant growth. If peat is not readily available, any partially decomposed vegetable compost can be used. Since the cost of adding commercial humus (peat) to the soil may be expensive, this should be given careful consideration, especially if acceptable results can be obtained by use of more economical compost.

7.2.2 PH Adjusters. The need for pH adjusters may be indicated by the laboratory test report and recommendations. A much wider pH range can be tolerated in soil for plants than in soil used in seedbed preparation. The pH scale for most soils ranges from 4.0 (strongly acid) to 10.0 (strongly alkaline) 'with 7.0 being neutral. Most plants absorb nutrients best from soils near pH 6.5, whereas most lawn grasses thrive best at neutral 7.0 to slightly alkaline. Ericaceous (acid-loving) plants do best in soil which tests at about pH 5.5. If available soil varies radically from acceptable levels of acidity or alkalinity, pH adjusters can be used. Measurement and thorough mixing are essential when adding these materials. Too much acidity in the soil is as detrimental to plants as too much alkalinity, even to such ericaceous, broad-leaved evergreens as azalea and rhododendron. PH adjusters are most readily available in two forms, lime and aluminum sulfate.

7.2.2.1 Lime. The addition of lime to the soil reduces the acidity. Most woody plants have a broad tolerance of acidity and require no adjustment to pH of the planting soil mixture. Certain ornamental plants may require that an alkaline soil condition be maintained on a permanent basis. Advice on how much lime may be safely added can be obtained from a reliable, long-established nursery or a County Agent.

7.2.2.2 Aluminum Sulfate. If soil tests reveal that the soil is too alkaline, it is generally good practice to add sulfur in the form of commercially available, acid-producing compounds having aluminum sulfate as a principal ingredient. Again, as with lime, advice should be sought concerning the quantity of such chemical necessary to achieve the desired PH.

7.2.3 Fertilizers. The use of fast-acting fertilizers in the soil mixture at time of planting is of doubtful value since plants are not able to use plant food effectively until they become established. Also, soluble plant food may leach away before the plants have recovered sufficiently to use it. In fact, large quantities of fast-acting fertilizer in the soil at this time may actually kill the plants. Therefore, better practice is to use slow-release fertilizer pellets in the soil or to top-dress plant pits and beds with a moderate amount of fertilizer at time of planting.

7.2.4 Soil Wetting Agent. Under heavy clay soil conditions that impede moisture penetration, the addition of a commercially manufactured soil wetting agent increases the ability of the soil to absorb water. Such an agent is especially useful in large plant containers for increased

moisture penetration prior to transplanting. Its cost may be justified in such limited areas as planter boxes, along with a soil conditioner, to make a friable soil mixture. Wetting agents may be applied by one of two methods :

a. As an additive in water solution;
b. In granular form as part of a planting soil mixture.

8. DRAINAGE. Most plants will not survive if the soils surrounding them remain soaked, because roots cannot absorb oxygen and the plants will "drown". Excess water will become stagnant and the roots of newly set plants will rot. Surface or subsurface drainage must be provided to collect and carry away excess water if the species of plant is not capable of enduring prolonged periods under wet conditions. Some plants, such as willows, grow better under these circumstances, but they are few in number. The reduced root system of newly set plants is more susceptible to suffocation from excess water than well-established plants. Collection of excess water may be accomplished by either of the methods described below.

8.1 Surf ace Drainage. Surface drainage in swales or ditches is the most common means of collecting water and providing positive drainage. This method is more economical than subsurface systems. When surface drainage swales or ditches must be crossed by pedestrian or automobile traffic, it is better to provide subsurface systems. Steep banks on swales and ditches should be avoided since they are difficult to maintain.

8.2 Subsurface Drainage. Subsurface drainage systems are the most permanent and effective means of collecting excess water from plant pits and beds. Subsurface drainage systems may consist of "french drains", open joint agricultural tile, perforated agricultural tile, or perforated plastic pipe. Collected waters can be channeled to a "sump", to the surface by daylighting at a low part of the site, or to a storm sewer system (Figure 1).

9. PLANTING OPERATIONS. High quality plants, carefully transported and transplanted immediately with careful adherence to the procedures described below, will usually become established quickly in their new environment.

9.1 Storage of Plants on the Site. Plants not planted on the day of arrival at the site should be placed in storage and treated as follows:

a. Outside storage should be shaded and protected from the wind to prevent drying of roots and tops.

b. Bare root plants should be heeled-in by placing the roots in a trench and covering with a 12-inch layer of topsoil, or by mounding 12 inches of topsoil around the roots, and thoroughly watering in either case.

c. Balled and burlapped plants stored on the project should be protected from drying out at all times by covering the balls with moist sawdust, wood chips, shredded bark, peat moss, or similar mulching material.

d. Plants, including those in containers, should be kept in a moist condition until planted by watering with a fine spray.

9.2 Plant Pits and Beds. Plant pits and beds should be prepared prior to delivery of the plants to permit immediate planting. A good rule for the size of tree pits is to dig them two feet larger than the diameter of the earth ball or the maximum spread of the roots and six inches deeper than the vertical dimension of the earth ball, or the maximum depth of the roots. Pits or trenches for shrubs should be dug only one foot wider than the spread of the roots, the diameter of the earth balls or the width of the container and six inches deeper than the vertical dimension of the earth ball or container or the depth of the roots (Figure 2). If the excavated soil meets the standards set forth under SOIL AND ADDITIVES, it may be used as backfill around the roots or the earth ball. If it is unsuitable, the soil should be removed from the site. For example, if the bottom of the plant pit or bed is impervious clay that may not allow water to drain out, corrective measures should be taken to prevent the plant from drowning. One or more of the plant pits should be filled to about a third of its depth with water after completion of digging operations. If water remains at about the same level for more than one hour, it is necessary to provide positive drainage. Methods of dispersing excess water are as follows:

a. Dig a 6- or 8-inch diameter hole at the edge of the pit, using a hand or mechanical post hole digger. The hole should reach a depth of 12 inches below the impervious soil layer. Fill this small hole with water for retesting. If water drains away, fill the post hole with coarse washed gravel and proceed with planting. If water still remains, dig deeper and retest.

b. Increase the depth of the plant pit or bed an additional six inches, fill with six inches of coarse washed gravel, and provide subsurface drainage to collect and disperse excess water away from the plant.

When it proves impossible or uneconomical to remove excess water from pits or beds using the above methods, the plants should be relocated or deleted from the project.

9.3 Placement of Plants. Plants normally should be set at such a level that after settlement they will bear the original relationship to the ground surface, as indicated by the clearly visible soil line at the base of the trunk (Figure 2). In some cases, plants are set slightly lower or higher than the original ground line under certain climatic or soil conditions. For example, palms are frequently planted considerably lower in loose, sandy soil for stability in windy locations and to reach a low

water table. Most plants, however, cannot tolerate being planted low and will die if their root systems are smothered by being covered with more soil than prior to transplanting. 'Even in arid climates, most trees and shrubs do not benefit from simply being planted in depressions in an attempt to capture moisture. The better methods are described below under "Future Watering". When planting large trees in recently filled areas where settlement is likely to occur under the heavy weight of the earth ball, the tree should be placed higher than the surrounding soil. In due course, it will settle and assume a "natural" relation to the surrounding ground surface. Sometimes, where water tables are high and where normal drainage of pits and beds is difficult or uneconomical, trees and shrubs may be planted in earth mounds. However, the relationship of soil level immediately above the plant's root system should remain as it was prior to transplanting. Planting soil should be prepared prior to placement in the pits. Dry soil should not be used as backfill but, if this is unavoidable, water should be kept running into the pit or bed to saturate the soil and settle it around the roots after planting.

9.3.1 Setting the Plants. The backfill soil should be mounded in the bottom of the pit or bed and tamped to minimize settlement and allow firm placement of the plants. Each plant should then be held in a vertical position and turned to take advantage of its natural characteristics for best appearance in a given location.

9.3.1.1 Setting Bare Root Plants. Firm enough soil carefully between the roots of bare root plants to fill all voids and fix the plants in the desired positions. Saturate the soil with water, allowing it to soak in around the roots, then fill the remainder of the pit or bed with soil to grade and tamp lightly. Form a soil saucer and fill it with water. Place a loose mulch around the plants to retain soil moisture and inhibit weed growth.

9.3.1.2 Setting Balled and Container-Grown Plants. Lift balled plants by the ball, and container-grown plants by the container, not by the plant stem, to avoid breaking the earth from the roots. Remove plants carefully from containers to avoid damaging the root system, by cutting away the containers and lifting from below the soil base. Remove any plastic wrap completely before the placement of backfill soil. Set the plants plumb and backfill with planting soil in tamped six-inch layers, working the soil under the sides of the ball to eliminate air pockets. After the plant is set, remove tying material, then loosen burlap and cut it away from the entire top of the ball. Firm each soil layer as placed until the pit or bed is half-filled and saturate the soil with water. Allow the water to penetrate, then fill the remainder of the pit with soil to grade and tamp lightly. Form a soil saucer and fill it with water. Place a loose mulch around the plants as above.

9.3.2 Future Watering. To facilitate future watering, maintain the soil saucer around individual plants. Where trees are planted in an area surrounded by paving, place at least one vertical "watering tube"

during backfilling to permit future watering of the root system. "Watering tubes" can be 4-inch agricultural tile, 4-inch perforated plastic pipe, or 4-inch perforated metal pipe filled to the ground surface with coarse washed gravel (Figure 2).

9.4 Pruning of Plants. Pruning away of branches should be done only to the degree necessary to balance the top of the plant to the root system which has been reduced by the essential operations of moving. If too much moisture is lost, the plant will die or it may drop its leaves. If defoliation occurs quickly and the leaves do not dry up and hang on, the chances are very good that the plant will send out new leaves after the root system has somewhat recovered. Evaporation of moisture through the leaves must be reduced to balance with the smaller intake capacity of the roots. A reliable guide is to cut back the branches of deciduous plants approximately one-third. Pruning of the secondary branches should be done so as to maintain the natural shape of the tree. Never cut a tree leader, the tip end of the main vertical stem or trunk. Removing the leader may cause a radical change in the natural growth pattern. Broken and frayed roots should be cut off cleanly above the injuries to minimize the possibility of decay. While this operation should be performed during the digging of the plant, a last-minute check on the condition of the roots during planting is recommended. It is not usually necessary to prune evergreen material at the time of planting, but local practices should be checked. The proper method of pruning is to use specialized pruning equipment, make all cuts cleanly, and treat the pruned surface of branches over one inch in diameter with a commercial tree paint (Figure 3).

9.5 Tree Wrapping. The trunks of deciduous trees over two inches in caliper should be wrapped with high grade burlap or a commercially prepared tree wrapping paper immediately after planting. The material should be wound spirally upward about the trunk to the second major branch and tied securely with twine. Wrapping of the trunk will retard evaporation and prevent sunscald and splitting of the bark. For aesthetic reasons, a dark brown wrapping is preferred since it is not as prominent in the landscape as lighter colors and does not emphasize the newness of the plantings.

9.6 Guying and Staking. The primary purpose of guying and staking trees is to prevent excessive movement of the trunk, thus keeping new fibrous roots from breaking their hold in the ball of earth and the surrounding new soil. However, artificial support is usually unnecessary except for trees with slender, weak trunks over two inches in caliper, for unusually large shrubs and in areas with adverse wind conditions. Guying or staking is to be avoided wherever possible, because of the labor and material involved. Unsupported trees tend to develop stronger and more resilient trunks. Guying of trees up to about S-inch caliper is usually done with three guys each consisting of two strands of 12-gauge wire attached to the tree trunk in such manner as not to injure the bark, and tied at the ground to heavy stakes or deadmen, or commercially available anchors. The bark must be protected from serious injury by using short lengths of garden hose, heavy cloth pads, or a combination of wood staves

and cloth. Guys may be tightened by inserting a small piece of wood between them and twisting the two strands of wire together, a procedure eliminating the necessity for turnbuckles. Guying of trees over five inches in caliper may require the use of four guys and more than two strands of wire for each guy, or wire heavier than 12-gauge. In lawns and near paved areas, guys may be a considerable inconvenience or an actual hazard, and "flags" must be tied to them (Figure 4). Staking does not have these disadvantages, but will furnish adequate support only for trees up to about four inches in diameter.

9.6.1 Methods of Staking. A good staking method is to use three 2- x 2-inch stakes each about nine feet long, or the equivalent in round natural poles, driven about one foot from the tree in an equi-lateral triangle to a depth of two to three feet, and connected at the tops by l- x 4-inch nailed-on-top braces. Alternate staking methods include the use of two stakes to the trunk protected from the wires by means of hose, cloth, pads, or staves. When using less than three triangularly placed stakes, particular attention should be given to the direction of the prevailing wind.

9.6.2 Staking Evergreen Trees. Evergreen trees up to six feet in height usually do not need support. One stake placed on the windward side of the tree normally will suffice if support is required. Evergreen trees between 7 and 12 feet in height should be guyed and anchored as outlined above for deciduous trees up to five inches in caliper. Evergreen trees higher than 12 feet should be guyed and anchored as outlined above for deciduous trees over five inches in caliper.

9.7 Mulching. Mulching is of value in all planting work, especially for soil erosion control where stable materials such as shredded bark hold the soil in place. The horticultural purposes of mulching are to retain moisture in the area about the plants by adding a surface covering of loose texture that gives shade to the ground beneath and reduces the loss of water through evaporation. In colder climates the mulch protects plants from the injurious effects of too frequent freezing and thawing. Mulching is well worth its cost under most circumstances, because it promotes growth and recovery and reduces the necessity of frequent weeding and watering. Mulch material should be placed over the entire limits of the plant pit or bed. Depth of mulch will depend upon the character of material used. Mulches are classified in two principal categories depending on their origin. The first and most widely used is "organic" mulch; the second is "inert", or inorganic. Frequently, either one is used for still another purpose, that of aesthetic appeal of planting beds.

9.7.1 Organic Mulch. One or two inches of shredded bark will give results equal to four or five inches of marsh hay. Forest litter, wood chips, and, in some localities, by-products such as cocoa bean hulls, nut shells, ground-up corn cobs, rotted sawdust, and other organic materials, are effective mulches; and, if too light, they can be held in place by spreading a small amount of earth on top of the mulch.' If sawdust is used, 7.5 pounds of ammonium sulfate or its equivalent should be added uniformly to each cubic yard of sawdust. This will aid bacterial

action; otherwise, the bacteria will use nitrogen in the soil and temporarily reduce the supply available for plants.

9.7.2 Inert Mulch. River bank stone, crushed rock, granite or marble chips are visually effective, but usually require a high level of maintenance to keep the plant pit or beds weed free. If a membrane is placed under the inert material to retard weed germination, a grid of small holes should be punched in the membrane one foot apart for drainage. Such inert mulches should not be used unless specifically called for on the planting plan, because their use is mainly a design matter. This is particularly true when colors of gravel or marble are specified.

10. ESTABLISHMENT. Maintenance must follow planting with such continuity that no period of neglect will endanger the successful growth of the plants. During the establishment period, many plant materials may exhibit abnormal symptoms such as defoliation, off-color foliage, smaller than normal leaves, or no flowering or fruiting. When plants are dug from the ground and transported to a new location, they take time to recover. Such plants are in a weakened condition. Don't panic and remove them! Allow time for recovery before deciding they must be replaced. The condition of new plantings should be ascertained by means of regular and frequent inspections. The following items should be checked and corrected as needed:

a. Does the planting need water?
b. Do the plant bed areas need to be weeded?
c. Is there any sign of disease, insect, animal or storm damage?
d. Do the plants need additional pruning?
e. Is the mulch in good condition?
f. Are the guy wires tight?
g. Are the protective hoses in place around the trees where guy wires are attached?
h. Is the tree wrap securely in place?

Maintenance during the establishment period includes watering, weeding and cultivating, fertilizing, control of diseases and insect pests, protection from small animal damage, and pruning, all of which are described below.

10.1 Watering. Lack of water immediately after planting is extremely dangerous, because the reduced root system has difficulty in supplying sufficient moisture to the top. If the roots are allowed to become too dry, the plant will die. When planting is done during warm weather, the danger is most acute; whereas, planting done in the late fall in northern regions will usually succeed if heavily watered at the time of planting. In most regions periodic watering will be required until the plants are firmly established, at least one year after planting. Rain cannot be depended upon to supply sufficient moisture to maintain a new planting.

10.1.1 Sources. A satisfactory source of water for new plantings should be determined well in advance of any planting operation. Except in housing complexes and other developed areas, watering from ordinary

hose connections may not be possible. Other more likely possibilities include use of water tank trucks, or pumping water from nearby ponds, streams, or wells through portable pipes, canvas hoses, troughs, or temporary ditches. In very dry regions, permanent underground irrigation systems may be justified. Technical assistance should be sought if such a system is considered feasible and economical.

10.1.2 Frequency and Method. The condition of the soil should be examined regularly and frequently to determine when watering is needed. In warm, dry weather the soil in a new planting can dry out in a surprisingly short time. It must be watered immediately if the soil is dry to the touch a few inches under the surface or if the leaves of plants are wilting. Watering should be thorough and frequent enough to assure that the root zones remain moist during the establishment period. Root balls serve as small reservoirs of available moisture before the growth of new roots will draw water from the surrounding soil. Also, to keep moisture from being drawn out of the root balls into dry surrounding soil, water should be applied slowly and allowed to soak into the ground until the surrounding soil reaches field capacity without runoff. This procedure develops deep root growth which is important to the plant in withstanding dry periods and accelerating its establishment.

10.2 Weed Control and Mulching. The area in and around newly-planted trees, shrubs, ground covers and vines should be kept weeded so that plants will not suffer from the competition of more vigorous weeds for moisture and plant nutrients. Mulching, as previously mentioned, helps materially in reducing weed growth and evaporation of soil moisture. Mulch should be maintained at the same depth and of the same type as when initially placed in the plant pits and beds.

10.3 Fertilizing. Nitrogen (N), Phosphorus (P) and Potassium (K) are the three chief chemical elements required by plants to produce good foliage and woody growth. These elements are present in varying amounts in most soils and form the basis for all fertilizers. Where plants become established in areas approximating natural conditions, with fallen leaves remaining around them, these elements are returned to the soil and provide adequate natural fertilizer. If plants are surrounded by pavement or located in a lawn where the leaves are raked and removed, the natural recycling of chemical elements is lost and they must be replaced periodically by fertilizing. The proper time to begin fertilizing will vary with different kinds of woody plants and growing conditions, but it is seldom beneficial to start applications of commercial fertilizers earlier than six months after planting. The type, amount and frequency of application of a fertilizer should be determined on the basis of the condition of the soil and the size and variety of plants involved. The most effective application method is usually by a grid of punch holes in the root zone, rather than by surface application, so as to reach both shallow and deep roots as quickly as possible without the danger of killing too many surface feeding roots with excessive amounts. In general, fertilizers containing a large proportion of phosphorus are desirable, because this is

the element contributing most to root growth. Slow-acting fertilizers are preferable to fast-acting or soluble fertilizers that leach away rapidly. Smaller and more frequent applications should be made where soil is sandy than where it is predominantly clay, because fertilizer dissipates more rapidly in highly porous soils. The best time to fertilize is shortly before a natural growing season. Plants should not be forced into lush growth by fertilizing during the latter part of a growing season to avoid freezing of tender new shoots. Specific recommendations on fertilizers and fertilizing methods can be obtained from a local County Agricultural Extension Agent, State University, Agricultural Experiment Station, or similar organization.

10.4 Control of Insects and Diseases. If plants have been selected with regard to their natural resistance to insects and diseases in the locality, control of infestations will generally be simplified. Planting and maintenance procedures described in this manual will also help to provide healthy growing conditions which reduce susceptibility of plants to infection.

10.4.1 Remedial Measures. If insect or disease damage or infestation occurs, remedial measures should be taken at once. Professional help should be obtained to identify the problem and recommend specific treatment. Depending upon the type and size of the affected plant, it is sometimes more expensive to control a disease than it is to replace the plant with a similar, healthy plant or with an immune cultivar.

10.4.2 Types of Insects and Their Control. Insect pests generally fall into four categories: (1) chewing insects which eat leaves, (2) sucking insects which extract juices from branches, stems or leaves, (3) boring insects which dig into the center of the wood, and (4) ground insects which can cause damage to roots. Other insects are often in abundance on and around plants, and some of them are the natural enemies of insect pests. For this reason, extreme care is necessary in determining the best means of controlling harmful insects while at the same time preserving the beneficial species. Chewing insects may be controlled by applying stomach poisons directly to the leaves in the form of liquid spray or dust. Other insects must be killed by contact poisons or by oil emulsions which clog breathing apparatus. Several insecticides have been removed from commercial distribution because of adverse environmental effects. Agricultural authorities and other experts in the locality may suggest ways to control insects besides the use of chemicals. Keeping breeding and harboring conditions for insects at a minimum and using biological control techniques (such as natural enemies) sometimes afford equally effective controls.

10.4.3 Types of Diseases and Their Control. This is a topic of great complexity and one which requires specialized, professional advice and services, should a problem arise. Among the most common diseases are those caused by wind-blown fungus spores or "damping-off fungi" in the soil. When leaves are diseased they show brownish spots which resemble rust, brown edges, raised lumps and general discoloration. Fungicides, commercially available in great variety, should be applied uniformly and

used as a preventative rather than as a cure. Directions must be followed very closely. Diseases of the roots are soil-borne and are difficult to cure other than by complete replacement of the soil. Galls, cankerous growths and certain parasites are more prevalent on weak plants than on those showing vigorous growth. The best defense against diseases is to keep plants in a healthy condition by periodic maintenance as described herein during the establishment period and thereafter.

10.5 Animal Damage. Occasionally, small ground animals will chew or gnaw the bark of some varieties of plant materials. This weakens the plant's natural defense against diseases and insects. If damage from animals occurs, a commercial pruning paint should be applied to the wound, after trimming away any damaged tissue and ragged bark. Protective cages fashioned from wire mesh or window screen may be placed around plants, or the base of plants may be painted with a commercial repellent, in localities where animal damage is likely to occur (Figure 5).

10.6 Pruning. Established plants of good quality should require little additional pruning beyond that done during planting. Additional pruning usually will be limited to the removal of dead or broken branches and some cutting back of shrubs to keep them within bounds. Pruning should always be done with a clean cut in living wood without bruising or tearing of bark and without "stubs" which could prevent the wound from healing. Horizontal cuts may cause rot and should be avoided. If it becomes necessary to remove large branches due to disease or damage, an initial cut should be made on the bottom of the branch to prevent stripping of the bark. All cuts made in branches one inch or more in diameter should be painted with a commercial pruning paint.

10.7 Removal of Guy Wires, Identification Tags and Tree Wrapping. Plants should be inspected periodically to determine if guying and staking devices or identification tags should be loosened. Growth in the diameter of tree trunks and branches can cause tight wires to cut into the bark. At the end of two growing seasons, all guys, stakes and tree wrapping should be removed. Tree wrapping allowed to remain any longer may foster the development of insect infestations on the bark.

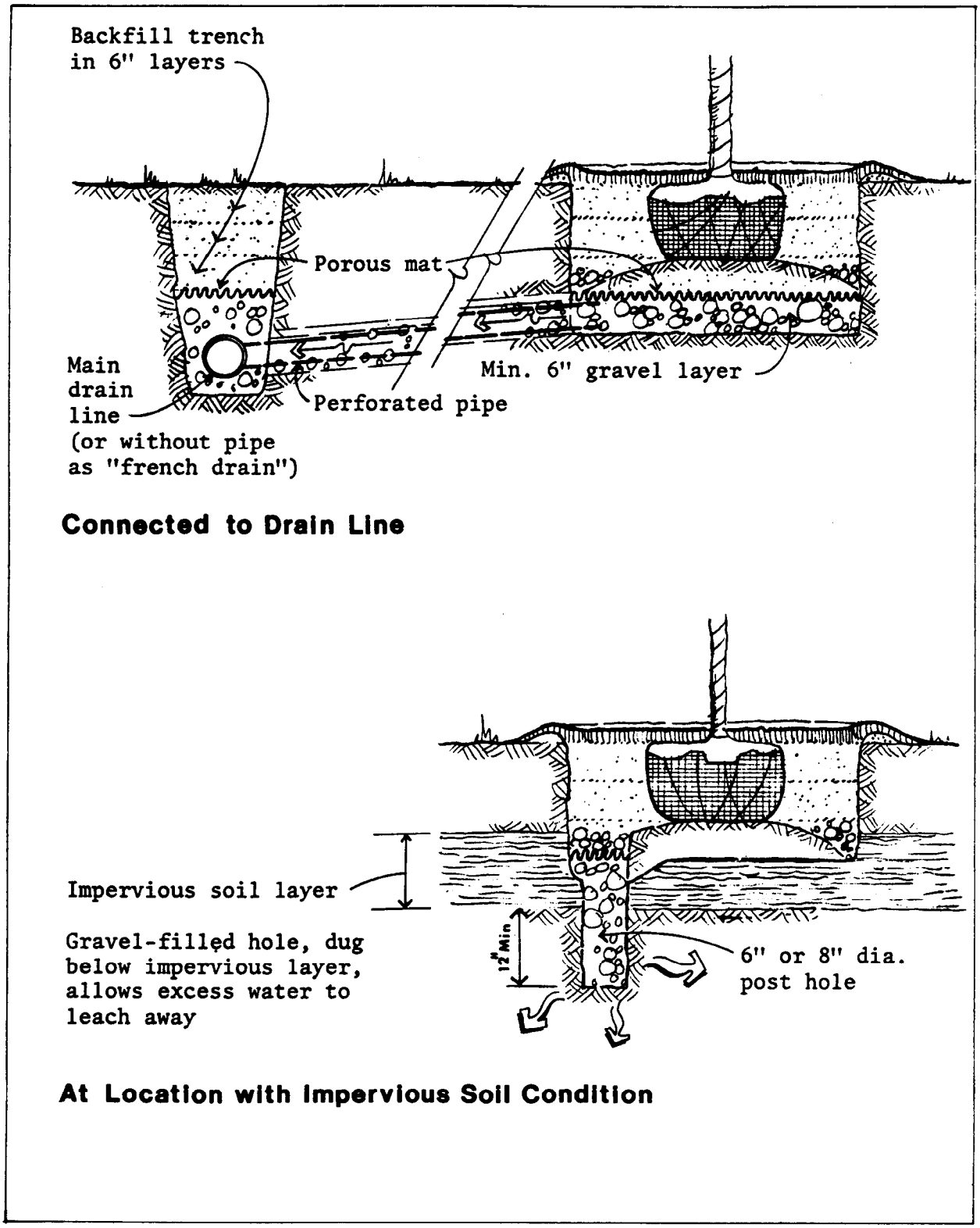

Figure 1. Subsurface Drainage of Plant Pits & Beds

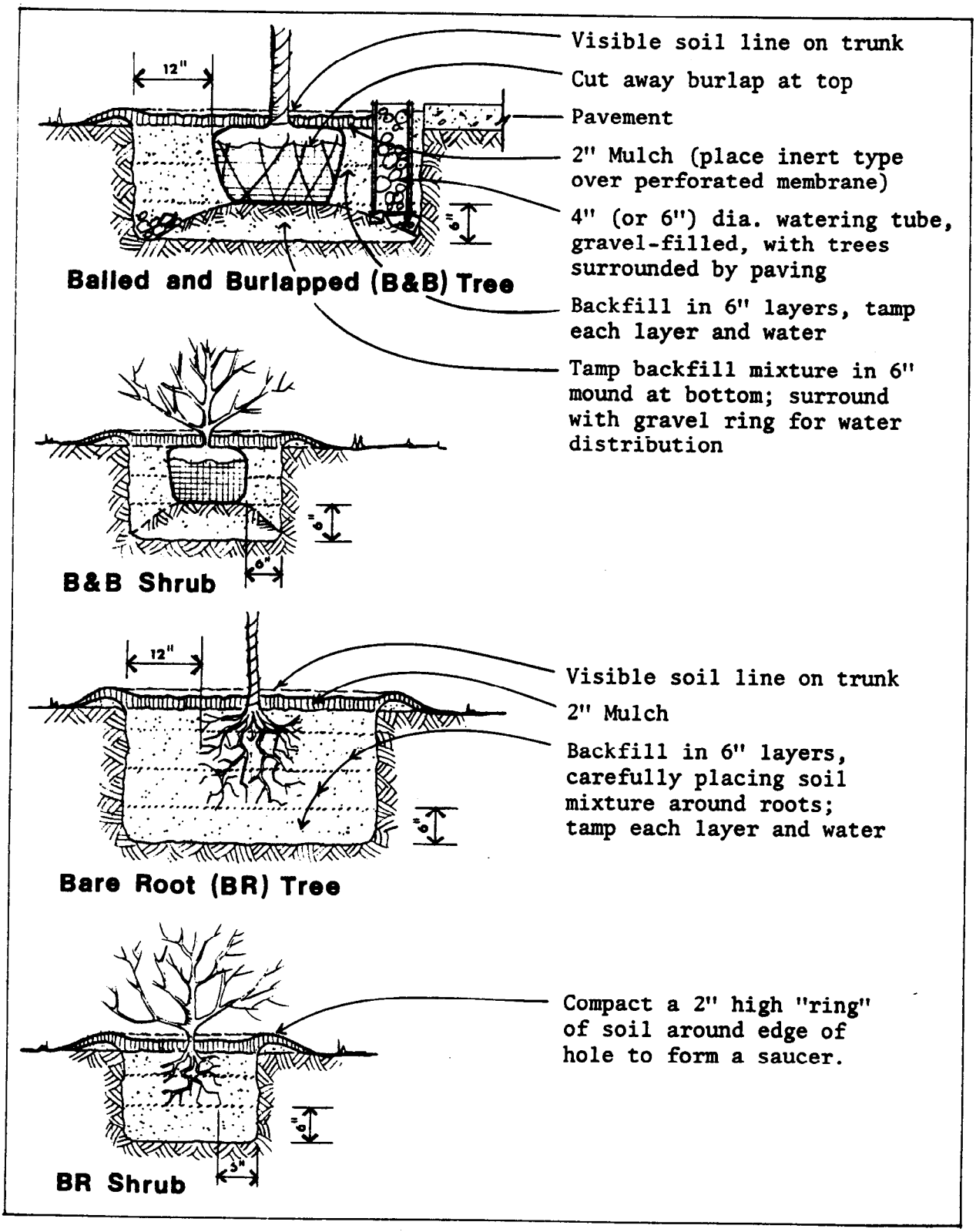

Figure 2. Planting Methods

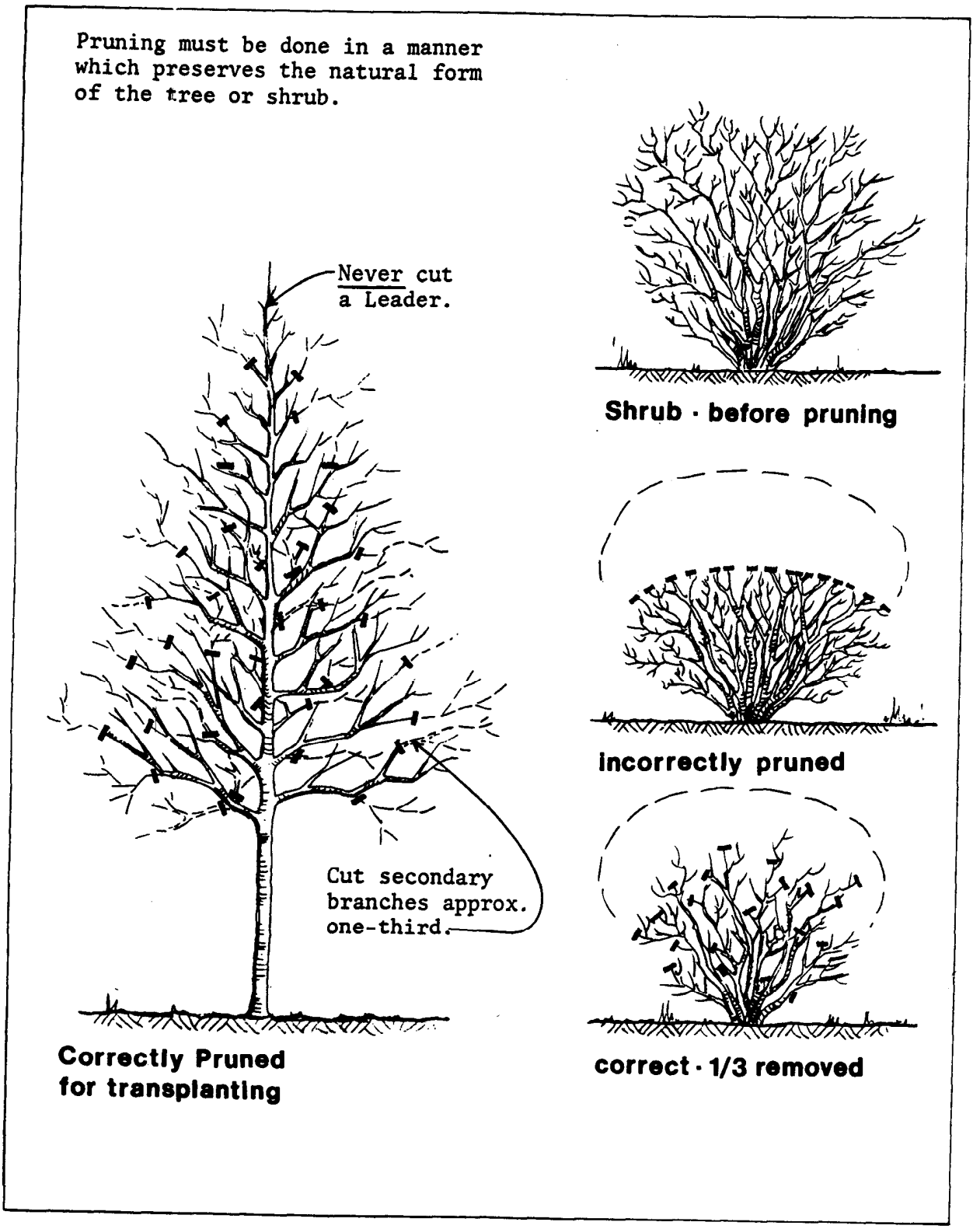

Figure 3. Pruning

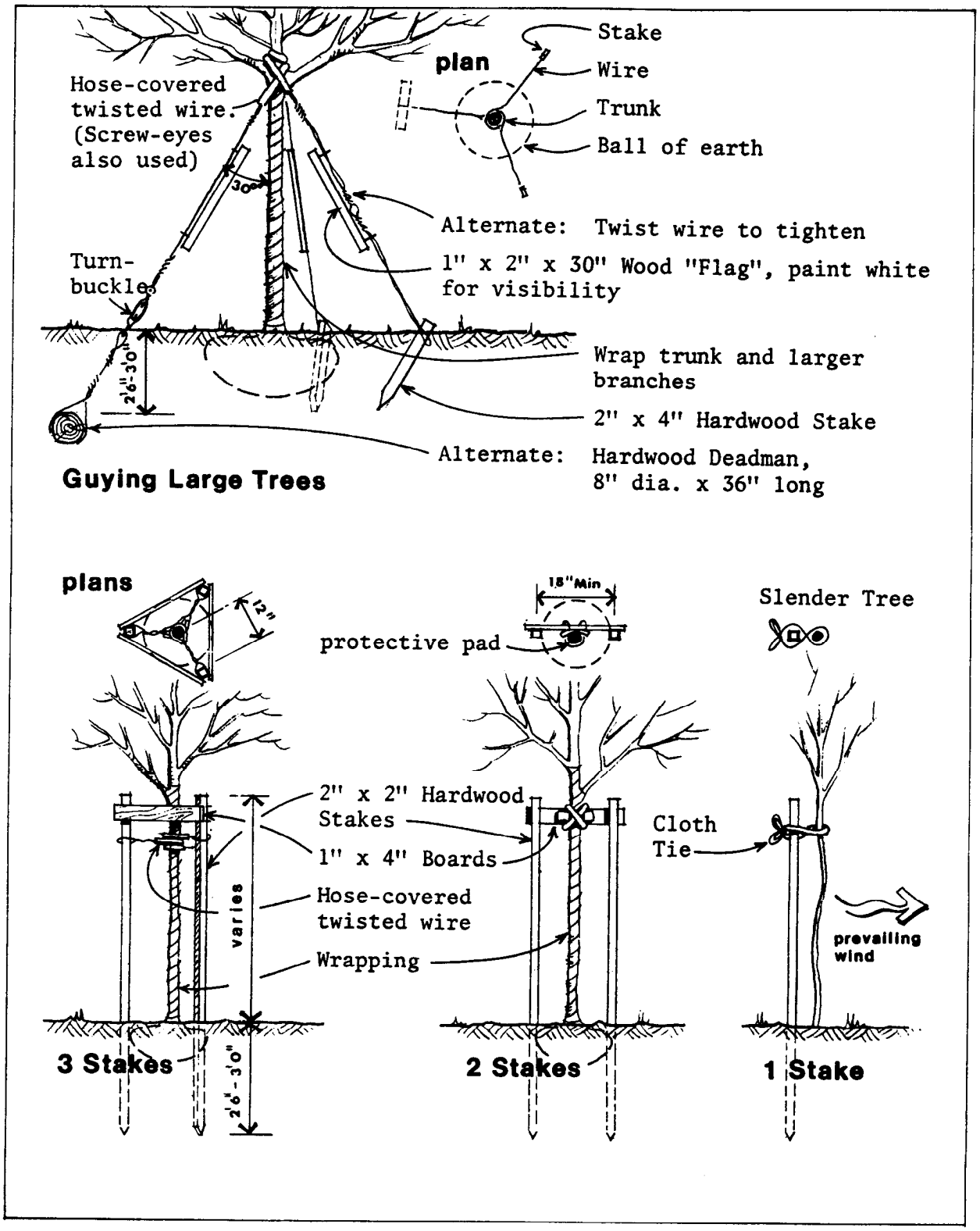

Figure 4. Guying and Staking

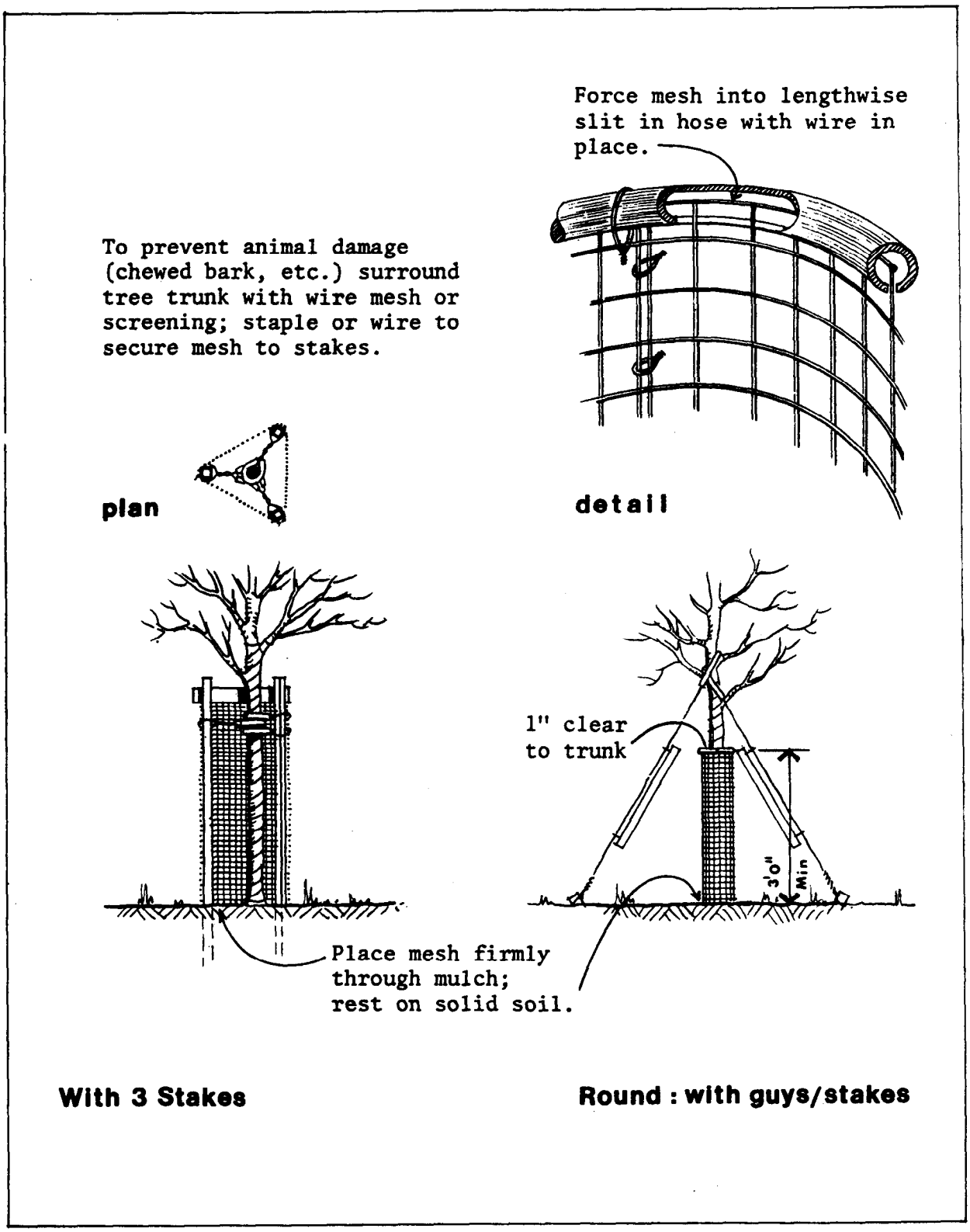

Figure 5. Protective Cages

APPENDIX A
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